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ASTRONOMY.

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Stephen

PROF. ALEXANDER'S EXAMINATION IN

ASTRONOMY.

MAY, 1877.

1. Why do we have more long days than short days in the course of a year, and in the southern hemisphere the reverse?

At Equinoxes days and nights are equal because only ½ of equator and parallels are lighted or obscured—When the sun has a N. inclination the N. will be illuminated more than S. because more than ½ is lighted.

As sun is larger than earth it will illuminate more than ½ at even Equinoxes by excess of a band of 15′ 52.3″. As the earth is a spheroid, we can add for refraction 34′ 54.1″ and the sum 50′ 46.4″ will indicate that the sunlight will begin *to fall on the N. Pole* when the *Sun is yet 50′ S.*

Continued sunshine will therefore commence at N. Pole about May 18 and end Sept. 25; at S. Pole it will commence Sept. 20 and end Mar. 22, a difference of eight days: which may be slightly protracted from refraction of cold regions—Hence as more light falls on N. Hemisphere and as the sun is longer present and covers more than ½ of each parallel we have more long days than short days.

2. How does it happen that we have the warmest weather in our Summer, when the earth is confessedly farther from the sun?

The earth's orbit is only slightly eccentric; the nearest approach occurs in the Winter of the N. Hemisphere, where the land is concentrated it is true, but only the water surface of the S. Hemisphere is presented to the sun, which does not absorb heat as fast as ground, which absorbs rapidly and accumulates a great deal during the long days of Summer, hence the warmer weather. We also get the direct rays of the sun then.

3. Is there any difference between a hot day in the Northern Hemisphere and a hot day under circumstances otherwise similar in the Southern Hemisphere?

The heat is generally more intense in the N. This is caused by the congregation of land masses in the N., which not being so open to the influences of the winds and currents, absorb and retain more heat, and each day adding its increment makes the hot days of the N. more *intense*. But a *single* day in the S. may be warmer.

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4. State the time of shortest twilight and give some idea of the reason why it is the shortest?

The duration of twilight is in general the shortest at the Equator—to a large extent it increases with the latitude. Also with comparatively few exceptions, its duration in mid-summer is greater than that in mid-winter—9th Oct. and 6th March—Twilight begins or ends at any place when the sun is 18° below the horizon. A place on a parallel in being borne out of the region of twilight will go over a greater part of its circumference than a place on the Equator, and hence it will endure longer.

In Winter or Summer the position of the sun in regard to either N. or S. Hemisphere will affect the continuance of twilight in proportion to its nearness or distance from each Hemisphere.

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5. Siderial Time—Solar Time—Apparent Solar Time—Mean Time—Equation of Time?

Siderial time, is the time obtained from the revolution of the stars—a siderial day has 23 h. 56′ 4.9″. (Reckoned from Vernal Equinox.)

Solar time, is time obtained by the apparent motion of the sun—it has 24 hours.

Apparent Solar time, is from sunrise to sunrise, and always varies in the length of its two parts, day and night.

Mean time is obtained by taking the average of the Solar days. (Both reckoned from the instant the sun crosses the meridian.)

The Equation of time is the difference between Apparent and Mean time. It gives what must be added or subtracted from the time of the sun-dial in different times of the year to make it correspond to the time of a correct clock.

6. Properties of a good measure of time or space?

1. That it should be adequate in the two respects of size and mode of application.

2. That it should be readily accessible.

3. It should, if possible, be invariable.

A good measure is the Diurnal rotation of the earth: because it determines the siderial day.

7. "The veritable *now*: the practical *now* and the eternal *now*: An instant a moment! 'A thousand years as one day and one day as a thousand years?' "

Space and duration are only relations of things.

An instant is a point in time, it is somewhere.

A moment is somewhat of a duration.

The veritable now is instantaneous.

The practical now has duration.

The eternal now is in space, forward, backward, upward or downward without power to cut itself off.

It is utterly impossible to measure the infinite by the finite. An inch is as good as the distance to the furthest fixed star.

8. A complete explanation of the aberration of light. The dragging of the shadows of the planets?

The annual aberration is a deviation of the *apparent* from the *true* direction of a beam of light, resulting from the earth's annual motion, in combination with the progressive motion of the light itself.

A beam of light being acted upon as though it possessed inertia, its impression on the eye of the observer will be two-fold, being the result of—

1st. The impression due to the velocity and direction of the light itself.

2nd. That due to the velocity with, and the direction in which the eye of the observer is borne by the earth's annual motion to meet the beam in the plane in which the beam descends.

The resultant of this two-fold impression will be represented by the diagonal of a parallelogram, the sides of which represent the magnitude and direction of the two *impressions* in question. The eye will consequently receive its impress in the direction of this diagonal and not in that of the side which coincides with the true direction of the descending beam; it must therefore really see the beam in the direction of the diagonal; and the angle which the diagonal makes with the side which represents the true direction of the beam will be the measure of the aberration.

Illustration: Rain drops falling in the face instead of on the head.

The angle of aberration will be greatest when the sides of the parallelogram are at right angles, i. e., when the direction of the earth's motion is at right angles to the direction of the beam of light.

In such a case therefore, the aberration will be a maximum in the plane in which the earth's motion is reckoned;—for the angle of aberration being very small it will be a maximum when its sine is a maximum.

As the direction of the earth's motion changes incessantly, the direction of this aberration in latitude will change with it.

The dragging of the shadows of planets is caused by the aberration of rays of light; which really seem to lean backward from the planets in their motions and thus give this appearance to their shadows.

9. Physical peculiarities of the sun? Spots, &c.? Cause of Sun's heat? Illustrations or measure of its intensity? Molecular constitution of the solar atmosphere? How ascertained?

It gives

1. Light.
2. Heat.
3. Support to life and activity.

Rotates in 25 d. 8 hrs.

Spots—limited to space 30° on sides of equator of sun. size varies. some 15 times diameter of earth and sometimes more. seldom continue long. Discovered first by Averroes of Cordova in 1100.

Their relative temperature less than the parts around them. They are hollow.

They have a nucleus which may have a ragged edge and Umbra or Penumbra which has a curvilinear edge.

There are on the sun Faculae. ridges. openings, shallows, nodules, corrugations, indentations and pores.

White heat:—Cause possibly electric. Sir J. Herschel. It has been computed that if the sun's diameter should diminish—in consequence of combustion or otherwise—2 ft. in 24 hours. 3000 yrs. must elapse before the apparent diameter would be changed $1''$. This is the most probable cause.

Heat is at least 2661°, 8 F. or can be 3201° F.

If the quantity of heat incident on the earth in a year were uniformly distributed and employed, without loss, in melting ice, it would melt a layer surrounding the earth of 101 ft. 4.14 inches—$3\frac{1}{3}$ inches a day. Heat at the surface of the sun is 84.888 times as great and would melt 38 ft. 8.566 inches in a minute or $11\frac{3}{4}$ miles a day.

The sun has no atmosphere beyond the luminous material—because the light of the edge of his disc is as intense as at the center. As far as there is any it is gaseous, because light from an incandescent gas is not polarized as is the case with liquids or solids.

By means of an instrument whose construction depends on the properties of polarized light

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10. The Zodiacal light? Hypotheses to account for it?

It was known long ago. More prominent in the tropics than here. In dry summer sometimes extends all across the sky.

Many suppose it to arise from a nebulous material not made into planets.

The objection to this is that the lower part of it should be wider than the rest. the light ought then to look like the tail of a comet but it does not.

Another Hypothesis is that it is an appendage of the earth; something like Saturn's rings, but rather a girdle of light. It revolves around the earth in the same time as the moon. The girdle also expands as the moon comes near the earth and contracts as it goes away.

11. The moon, why she always presents nearly the same face to the earth? Dark and light portions of the moons disc? How we know that she is rough? Character and height of her mountains? Her atmosphere if any? Lakes or seas on the moons surface? Earthlight? Eclipses of the moon. Why she is not wholly invisible when wholly immersed in the earths shadow.

Because the moon revolves around the earth in 27½ days and on its axis at the same time it generally presents the same face to us although we sometimes see a little of the other side on account of the inclination of the orbit.

That it is a globe one half of which is light and the other dark is shown by its crescent form increasing regularly from a narrow semicircular line to a complete disc, corresponding to the appearance a globe would present, one hemisphere of which was black, the other white when differently turned toward the eye, so as to present a greater or less portion of each.

We know that the moon is rough in two ways.

1. Because we can see the rough places as so many mirrors.
2. Because we can see every part of it.
   a. It appears like unchased silver.
   b. We can see it to be mountainous.

The sun illuminates the mountain tops first, the slant edge is illuminated all the way to the top: as the sun rises the shadows shorten.

The mountains are volcanic and changeable in their natures, steep on account of nature of the materials: feeble gravitation, and absence of wearing action of water and moist air.

Height in miles.

Newton	4.514
Tycho	3.8261
Casatus	4.3227
Possidonius	3.7558
Huygens	3.5367.

Rays of sun reach this last 9 hrs. sooner than rest the of the regions. On the earth it would be reached 12 min before the plain below.

The effects of an atmosphere cannot be traced Stars move toward and are hidden from view but are not displaced by *refraction* nor dimmed by any sensible *absorption* of their light—and are hidden as long as the moon would require if she had no atmosphere—and we can see no clouds in the atmosphere of the moon.

Lakes or seas? Has no large collections of water or other liquid, as one of considerable size would reflect the sun and its outline would be neatly curved, but this has not been observed and where it does cross these spots it is uneven

Phases?

These monthly changes in appearance arise from the moon—an opaque body—being illuminated on one side by the sun and reflecting from it in all directions a portion of the light so received. When the dark side of the moon is shown to the earth it is new moon and when the bright side, it is full moon, &c.

Gravity on the moons surface—very slight--gravitation on the surface of a sphere varies as $\frac{\text{mass}}{(\text{radius})^2}$ hence gravitation on earth is to that on moon as 6.53 : 1 or 2 13th of that on the earth, which can be diminished by 1-5000th at the middle of the hemisphere opposed to the earth. A heavy body would fall from a state of rest 2 ft. 5.59 in. in first second of time. This must be diminished $\frac{1}{4}$ inch. on highest mts. and increased as much for deepest cavities.

A seconds-pendulum would be 5.9985 inches long.

Earthlight?

The light reflected from the earth to the moon is again returned to us and is visible for some time before and after new moon Its color is ruddy because it has passed through the atmosphere 3 times. The atmosphere reflects the blue and transmits the red rays

Eclipses occur when the moon is in the shadow of the earth. One half the moons journey is performed above the plane of the ecliptic one half below; hence twice in each revolution the moon is in that plane, at those parts of it called nodes. If the moon is new and is at a node between the earth and the sun is eclipsed but if it is full and the earth is between it and the sun, the moon is eclipsed.

A total eclipse of the moon may last $1\frac{3}{4}$ hrs.

Even when totally eclipsed however the moon's disc is scarcely ever wholly obscured; the suns light is bent by the earths atmosphere toward the moon and sometimes tinges it with a ruddy color.

12. The tides?

Differ from waves in cause, extent and regularity of occurrence.

Rising water--flood tide. Highest flood—high water.

Falling water—ebb tide. Lowest ebb—low water.

Interval between two successive tides 12 hrs. and 26 min. hence high-water 52 min. later on each successive day.

Production of tides. Causes are sun and moon. Moon greater on account of nearness.

Tidal wave on the side of earth toward moon is caused by the water being attracted, and being free to move it goes, the counter wave on the other side is caused by being less attracted because further off ∴ simultaneous areas of high water are 180° apart one near and one opposite the moon. Simultaneous areas of low water are two, midway between those high tide, and they advance at equal intervals.

When the earth sun and moon are in a line the attraction is greater hence high water is higher, low water is lower. This is in 2d and 4th quarters of moon and called spring tide. When the sun and moon are at right angles to the earth one neutralizes force of other. This is in 1st and 3rd quarters of moon. High water lower, low water higher, and called neap tides.

Highest spring tides when luminaries are nearest i. e. at equinoxes, Mar. and Sept. Lowest neap tides at solstices.

Height of tides depends on local circumstances. The normal height is 2 ft. (Pacific Ocean) but where it dashes against a continent it is higher, average 9--12 ft. Goes as high as 70 ft.

13. The Calendar? origin of the names of the day of the week? Reformation of the Calendar? Old Style and New Style? Date of the year?

καλεω to arrange division of time—epochs and eras.

A Solar year has 365 days 5 hrs. 48 min. 46.0544 sec.

In every year 52 weeks and one day so the next year begins one day later, and this series will not run through for 28 yrs.

A solar cycle—28 yrs.
A lunar cycle—19 yrs.
A Pascal cycle—28x19—532 yrs.
Roman Indiction—15 yrs.
Julian Period—532x15—7980.

Dominical letters.

Jan. —A—At.
Feb. —D—Dover.
Mar. —D—Dwell.
Apr. —G—George.
May —B—Brown.
June —E—Esquire.
July —G—Good.
Aug. —C—Christopher.
Sept. —F—Finch.
Oct. —A—and
Nov. —D—David.
Dec. —F—Fryer.

		Saxon.		Roman.
Sunday	—	Sun's day	—	Sun.
Monday	—	Moon's-day	—	Moon.
Tuesday	—	Tiw's-day	—	Mars.
Wednesday	—	Woden's-day	—	Mercury.
Thursday	—	Thor's-day	—	Jupiter
Friday	—	Frigga's day	—	Venus.
Saturday	—	Seatur's-day	—	Saturn.

The Thebans discovered that there was not an exact no. of solar days in a solar year—and at the time of Julius Caesar, Sosigenes the Egyptian astronomer recommended that one day every four years should be added by reckoning the sixth day before the kalends of Mar (Feb. 24) twice hence Bissextile. But here too much was added and in 16th century the correction amounted to 10 days.

Pope Gregory XIII. then made this rule.

Every year divisible by 4. (except the secular years 1800, 1900, &c.,) to be a bissextile or leap year containing 366 days—every year not so divisible to consist of only 365. Every secular year divisible by 400 to be a leap year; every one not so divisible to consist of 365. The error now amounts to only 1 day in 3,866 years.

The Julian Calendar was introduced in 46 B. C. The Gregorian in 1582 A. D. This was not accepted in England till 1752 when the 2d of that month was called the 14th. This was called new style in contradistinction to the old style.

Date of the year should be 1882. Christian era commenced too late.

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14. Laws of Planetary distance? Half Planets?

Nebular Hypothesis of La Place with its modification?

The fixed stars, their distance and their molecular constitution? Binary stars and the Milky Way? Clusters and nebular?

The hypothesis of the spheroidal origin of clusters and nebular?

A ratio of 9 to 5 runs between the distances of the planets.

Thus 5-9ths of distance of Neptune gives Uranus—5-9ths of Uranus gives Saturn. There ought to have been a planet between Earth and Venus according to this calculation. Dr. Alexander calls these, i. e., Earth and Venus, "Half Planets." Uranus an exterior half planet, and there is a half planet missing between it and Saturn. The rest are whole planets except Earth and Venus. Earth is an exterior planet. Venus interior.

General Law,—Law of distances in general is that there is a geometrical progression in the distances of the planets from the Sun, in ratio of 9 to 5. It begins with Neptune. Intervals between Uranus and Saturn and Earth and Venus. This interval is $\frac{1}{2}$ ratio. $\frac{3}{4}$ ratio is true for Uranus.

Planets were not flung off from the Sun; they were abandoned by the Sun.

La Place started with a revolving Sun. State of dynamical equilibrium. The centripetal force was a little superior. The outward fling diminishes faster than the attraction. When the sun shrank it left a ring behind, thin and narrow. The outside of this ring was going faster than the inside. This ring might cool down, nicely balanced, but not likely to do so. Saturn's rings would be one example. Ordinarily one part of this ring would circle before another, then the whole thing would be broken up into a string of nebulous beads nicely balanced. One of these beads being larger, attracted others, and soon all are absorbed, wound up. If there is nothing to disturb it, it will roll up so as to turn round in the same time as the ring.

When one bead does not absorb the others, but all remain. All the larger planets have atmospheres left in cooling.

Jupiter prodigiously hot.

Spheroidal form due to rotation.

Modification.—When the large planets began to cool down, small rings would be formed at close quarters. This causes them now to revolve around the planet in the same time as they turn on their axes.

In a rare case, if the planet allows the army of satellites to be formed before the rings are formed, they keep the rings perfect.

Missing planet; what became of it. It was not broken into asteroids or they would have been felt.

Saturn absorbed the missing planet and divided it up into shells and made these satellites before the rings were formed.

Fixed stars are those which have a high degree of permanence as to apparent relative situation. This expression, "fixed stars," is to be understood in a comparative and not an absolute sense, it being certain that many, and probably that all, are in a state of motion, although too slow to be perceptible, unless by very delicate observations. *Fixed Stars are Suns.* The distances of the stars from us are so great that to state them in miles hardly gives an adequate idea of them. Some other method must be used and the velocity of light affords us a convenient one.

Light travels at the rate of 185,000 miles in a second; that is to say between the beats of the pendulum of an ordinary clock, light travels a distance equal to 8 times round the earth. Now the nearest star, (leaving Sun out.) is situated at a distance which light requires 3½ years to traverse. On an average light requires 15½ years to reach us from a star of the first magnitude, 28 years from a star of the second, 43 years from a star of the third, and so on, until for stars of the 12th magnitude the the time required is 3500 years. If a star of the 6th magnitude were destroyed now, we should see it in the heavens for 120 years to come.

They are white, yellow and red in color. Showing a gaseous condition.

Binary stars are pairs of stars in which there is an orbital motion round a common center of gravity. These Binary stars consist of sidereal systems, composed of two stars revolving about each other in regular orbits—ellipses.

Milky Way. The stronger telescope we get the more stars we see. The light from them started before the creation of man.

A broad generalization in regard to clusters and nebulae is that they have no great central force in the heavens as the dynamical equilibrium was destroyed; and that their original form was spheroidal.